Smart Infrastructure

A RESEARCH REPORT FROM **THE CENTER FOR DIGITAL EDUCATION** AND **CONVERGE**

CENTER FOR DIGITAL EDUCATION converge

THE IT TEAM FROM ST. VRAIN VALLEY SCHOOLS, COLO. (FROM LEFT TO RIGHT):

GREG MARTIEN, NETWORK ENGINEER

MARK SCHUTT, NETWORK ENGINEER

JOE MCBREEN, CIO

DARRIN TAMS, SENIOR SYSTEMS ADMINISTRATOR

NOW IS THE TIME TO DREAM BIG about constant access for all users — some with multiple devices — on all campuses. The trends of mobility and the transition to all digital curriculum materials are barreling at us like a freight train. It's a competitive issue for higher education and it's imperative in K-12 for student engagement.

I've learned from numerous IT executives that "wireless is hard." With the complexity of so many buildings on large campuses, it *is* difficult, certainly more difficult than past wired networks have been. One school even said that every time someone popped popcorn in its microwave oven, it brought down the wireless network.

These are stressful times for network techs, but they are also full of opportunity. We wanted to help K-20 schools by providing them with new strategies and solutions that enable them to think smarter about their IT infrastructures — to identify new ways of thinking about costs, security, access provisioning and much more.

We're delighted to present this Special Report on Smart Infrastructure, which we believe will be a useful tool in the year ahead for many schools.

LEILANI CAUTHEN
Publisher, Converge Special Reports
Converge/Center for Digital Education

IT SUPPORT FOR EDUCATION INSTITUTIONS continues to get tougher each year. We are in the midst of a decade of transition from traditional learning models to technology-infused learning models. This transition involves student devices, classroom devices, learning engagement tools, new assessment vehicles, cloud-supported resources, enhanced communications platforms and dashboards to make sense of big data metrics. And all the while there is the ever-growing concern that data and digital resources are kept secure while opening up access to a more diverse set of users.

The expectation on campuses is that all of this will act transparently to the user's experience, regardless of whether it is an institution's device or a personal device. Additionally, operational budgets are not climbing in a way that would correspond to this increase in demand. Institutions must become more innovative, think creatively and work more cooperatively to make all of this work.

This Special Report looks at what districts and institutions have been doing to address these diverse and countervailing issues. We hope that you gain an appreciation for the job at hand and come away with some ideas on what you can adopt in your school setting to make your infrastructure smarter.

JOHN HALPIN
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STAYING SMART IN A COMPLICATED WORLD

Education leaders are looking for answers. Rapid technological innovation in the last five years has eclipsed educational systems that were built for an era of teaching and learning that is constantly evolving. Outdated systems, networks and processes are increasingly unable to support students who own — and want to use — four to five digital devices, instructors who strive to expand student learning beyond the four walls of a traditional classroom, and administrators who are looking to capitalize on opportunities to reduce expenses and increase positive outcomes for student achievement.

The changes that are occurring on campuses can move alarmingly fast for education leaders who are trying to keep their heads above water. But the simple truth is that these demands are only going to become more complex as mobile adoption continues to increase; learning environments evolve to include blended, online and hybrid models; online assessments, backed by Common Core State Standards requirements, become standard operating procedure; and data storage capacity needs to scale to petabyte levels.

As K-20 education institutions try to keep up with these truths, one common obstacle stands in their way: outdated IT infrastructures.

Education leaders know that infrastructure is a sticky business. Replace one part and something else breaks. Purchase technology without being prepared and waste precious resources. Implement a system that doesn't play well with others and you have a real problem on your hands. Educators are looking for trusted leaders who know their pain points and understand their challenges. With tight budgets and little room for error, they need to be confident that the money they spend will position them for at least the next three to five years, as technological innovation and adoption only continue to increase.

This Center for Digital Education Special Report looks at some of the key trends that are impacting IT infrastructures and gives specific guidance on what smart strategies, decisions and solutions K-20 institutions can implement to ensure that they are well prepared to take advantage of the inevitable technological changes coming their way. ■

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EDUCATION'S CHANGING LANDSCAPE

The Trends That are Impacting Your IT Infrastructure

To say that the educational landscape is rapidly evolving would be an understatement. The technological changes that have created a more connected society have pervaded K-20 education and are impacting campuses' often aging infrastructures. Here we look at the trends that are creating the biggest impact.

Mobile Device Adoption

The increase in mobile device adoption by students, instructors and faculty should come as no surprise to anyone that has followed the education market the past five years, but this trend also shows no sign of disappearing — or even slowing — in the near future.

According to a Project Tomorrow *Speak Up* Survey released in October 2012, nearly 50 percent of high school students and 40 percent of middle school students owned or had access to a smartphone or tablet — a 400 percent increase since 2007.[1] The report also noted that 27 percent of administrators were exploring the idea of allowing students to use mobile devices at school, despite being reluctant to allow this in the past. Parental approval of smartphone usage increased with 62 percent of parents saying they would buy their child a mobile device if it would be used for academic purposes.[2]

In higher education, according to EDUCAUSE's ECAR Study of Undergraduate Students and Information Technology in 2012, most college and university students (86%) owned laptops as their primary computing device for academic purposes, but more students in 2012 than in previous years owned tablets (15%), smartphones (62%) and/or e-readers (12%).[3]

Teachers and administrators, too, are attached to their devices. A Center for Digital Education (CDE) survey of nearly 150 IT professionals in K-20 education — conducted for this Special Report — revealed that 84 percent of respondents said that faculty and staff bring a personal device to work (laptop, tablet or smartphone) that they use to access their school's or college's network.

Evolving Learning Environments

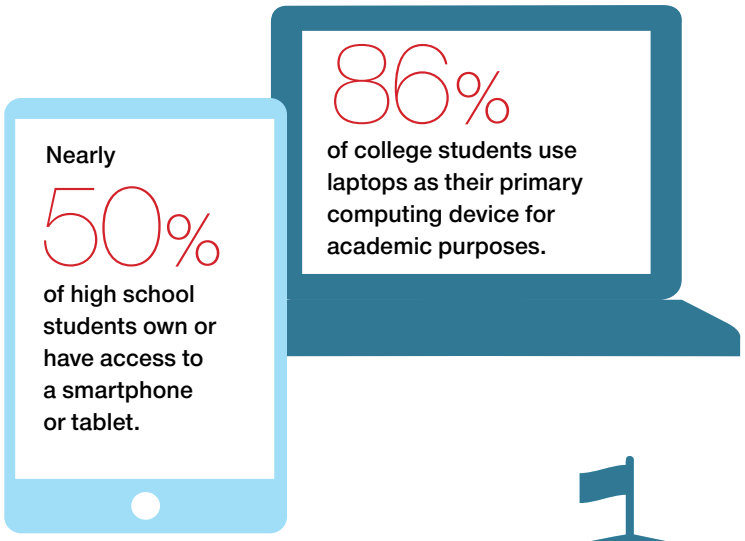
At the same time mobile devices have made a permanent presence on K-20 campuses, the traditional classroom model has also shifted. Online learning has broken down barriers and lifted the constraints of time and location. Students can increasingly choose the learning style that best fits their individual needs.

Flipped classrooms, for instance, where class lectures, instructional–based videos and other content are viewed online at home and then discussed in school, are increasing in popularity. Additionally, fully online and blended (hybrid face-to-face and online) learning environments have become increasingly pervasive in recent years in both K-12 and higher education.

In January 2013, the Education and the Workforce Committee reported that an estimated two-thirds of school districts offered blended learning programs.[4] A 2011 Project Tomorrow *Speak Up* Survey found that about one-third of responding middle and high school students were enrolled in at least one online class.[5]

Online learning in higher education is even more prevalent. According to CDE's Digital Community Colleges Survey, more than 90 percent of community colleges reported substantial increases in online, hybrid and Web-assisted courses.[6]

WHY BEING SMART ABOUT OUR IT INFRASTRUCTURE NOW IS SO CRITICAL



86%

of college students use laptops as their primary computing device for academic purposes.

Nearly

50%

of high school students own or have access to a smartphone or tablet.

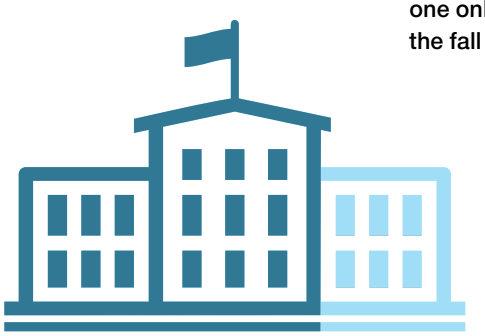
More than

6.7M

higher education students took at least one online course during the fall 2011 term.

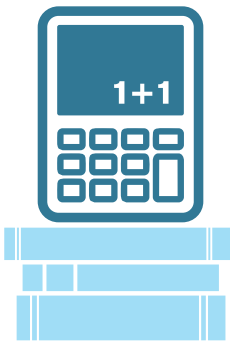
25%

of respondents to the CDE survey expect their data to grow 21% to 40% in the next year.



2/3

of school districts now offer blended learning programs.



The Common Core State Standards online assessments in English and math go into effect by the 2014-2015 school year.

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Technological trends are having a big impact on learning and the time and place in which learning occurs — making it critical that IT infrastructures keep pace.

FLICKR/FLICKINGERBRAD

Additionally, the latest 2012 annual survey of online learning conducted by the Babson Survey Research Group, with support from the Sloan Consortium and Pearson, shows that more than 6.7 million higher education students took at least one online course during the fall 2011 term, an increase of 570,000 students over previous years. Thirty-two percent of higher education students took at least one course online, and 77 percent of academic leaders rated the learning outcomes in online education as the same or superior to face-to-face courses.[7]

Online Assessments

Online assessments have gained prominence as they are now a central objective of the Common Core State Standards (CCSS), which are a common set of goals and objectives designed to unify key minimum requirements of what U.S. students are learning in the K-12 environment.

For the 46 states and the District of Columbia that have adopted the CCSS, online assessments in English and math will be mandatory by the 2014-2015 school year. Once online assessments are in place, all students in a grade are expected to be able to take the tests simultaneously.

Data-Driven Everything

As education has progressed into a more digital age, systems are accumulating increasing amounts of varied data — including student data, faculty data, assessment data and financial data. This diverse data has reached the scale that is now being classified as "big data," defined by the McKinsey Global Institute as "data sets whose size is beyond the ability of typical data software tools to capture, store, manage and analyze."[8]

Big data creates an opportunity for educators to transform education in ways never seen before, including implementing personalized learning, ensuring real-time intervention and improving teacher effectiveness, among many other possibilities.

But big data is notoriously hard to wrangle — or even to understand. The Global Language Monitor, a media analytics company, named "big data" the No. 1 most confusing technology term for 2012.[9]

The CDE survey found that as education leaders address big data, they are confronting challenges: Twenty-one percent of respondents identified overall storage capacity as their biggest data-related challenge, and 27 percent identified lack of analytics as their biggest challenge. ■

"As student expectations for technology in the classroom continue to grow, it is imperative that school districts look to improve infrastructure that will meet these increasing demands."

JULIE SMITH, VICE-PRESIDENT, K-12 EDUCATION SALES, CDW•G

"The future of networking (and indeed, IT) is about agility. **The road forward, therefore, will be centered around software.** In particular, in the near future we will see programmable infrastructures comprised of compute, storage and networking that work together to provide new kinds of cloud, mobility, and security products and services."

DAVID MEYER, CTO AND CHIEF SCIENTIST ROUTING PRODUCTS, BROCADE

"When we look at smart infrastructure for education, we look at it in three layers: the identity layer, the data layer and the application layer. **That allows us to craft each layer to handle multiple devices and multiple roles.** A key thing in education is that the role someone has is the best way to determine what they need to see and how they need to see it."

BILL KILCULLEN, PUBLIC SECTOR EDUCATION SOLUTIONS BUSINESS DEVELOPMENT DIRECTOR, MICROSOFT

"People have always used the network as the main point of their security. We might have some security on our laptops and desktops but you still absolutely need network security, and this is the same for mobile devices."

KEVIN FLYNN, SENIOR MANAGER, MARKETING, FORTINET

"The definition of infrastructure is dramatically changing, and the definition of what a learning environment really is as well. Smart infrastructure means a transformation to enable all learning online, and is the community of learners in a virtual sense, not the buildings."

JAIME CASAP, GLOBAL EDUCATION EVANGELIST, GOOGLE

"Conventional Wi-Fi technology was never designed or conceived for the kinds of issues that the education market now faces with their users armed with many Wi-Fi enabled devices. **Most Wi-Fi systems simply can't cope with interference or the simple change in orientation of these devices** which can negatively affect performance."

DAVID CALLISCH, VP, MARKETING, RUCKUS WIRELESS

"Every school and college campus requires a robust wireless network for its students and staff. **Design, implementation, intelligent carrier grade equipment and managed networks are critical to support** the hundreds of wireless student devices accessing content, videos and collaboration tools."

ALAN JACOBS, BUSINESS DEVELOPMENT MANAGER – EDUCATION, SPRINT

FOUNDATION FIRST

Creating a Strong Wi-Fi Infrastructure Plan

Each of the aforementioned trends can benefit from robust Wi-Fi access for their successful implementation, and, accordingly, each can create challenges for any education institution that lacks a robust Wi-Fi infrastructure foundation. To address wireless challenges and ensure consistent connection, institutions must maintain an up-to-date and sophisticated Wi-Fi infrastructure plan that can scale as the need for more bandwidth will inevitably increase as time goes on. For example, according to the State Educational Technology Directors Association (SETDA), internal Wide Area Network (WAN) connections from the district to each school and among schools within the district should be at least 1 Gbps per 1,000 students/staff by 2014-15 and at least 10 Gbps per 1,000 students/staff by 2017-18.[10] That means that schools will need 10 times the amount of bandwidth in only three years.

The good or bad news — depending upon how you look at it — is that most education institutions have their fair share of challenges in this area. According to the CDE survey, only:

- 31 percent of respondents said their connectivity was good enough for learning applications and the downloading of digital content.
- 28 percent of respondents said their connectivity was adequate for online testing and assessment.
- 30 percent of respondents said their connectivity meets their needs for video streaming.

The reasons listed for connectivity deficiencies:

- 10 percent said their connections were too slow.
- 13 percent said they lacked wireless coverage.
- 22 percent said that they had to deal with an overall lack of capacity to adequately serve students and staff.

Reasons for these challenges include the fact that many institutions must frequently contend with aging structures that have architectural layouts featuring enclosed classrooms, long hallways, and remote and temporary buildings. In many cases the older buildings on campus were built with construction materials that can prevent radio frequencies from smoothly passing through walls.

Additionally, traditional WLAN (Wireless Local Area Network) solutions require complex site surveys, channel planning and ongoing radio frequency tuning. To complicate matters, WLAN deployments are typically phased in over time, necessitating ongoing changes to the network design. The wireless deployment may also be modified as more users are added, or new applications are deployed.

FLICKR/ALAN LEVINE

Lev Gonick, Vice President of Information Technology Services and CIO, Case Western Reserve University, Ohio

These changes to the WLAN design are extremely complicated to plan, with potential ripple effects on the existing deployment, due to the limited number of non-overlapping (usable) channels. In particularly crowded areas, moreover, access points are placed closer together to take advantage of higher data rates, increasing the speed at which clients transmit data. However, careful planning will help avoid channel interference and network congestion.[11]

According to Lev Gonick, vice president of Information Technology Services and CIO for Case Western Reserve University in Ohio, "Wi-Fi is and always will be a shared network resource — that is to say, if there are 10 people on the highway consuming the road, they will have a very different experience than if there were 100 people on the highway. It's a fundamental design constraint with which we have to live."[12]

To address these challenges, K-20 education leaders need to develop a Wi-Fi infrastructure plan that includes smart strategies and solutions to prepare their campuses for what can come in the future.

Adding Access Points, Controllers and Management Software

The most frequently utilized option for enhancing Wi-Fi at any institution is to physically deploy more access points (note that this can bring both new device costs and additional labor costs).

Additional access points can be installed in ceilings and under stairwells, as well as other places around where people work, study and/or live. Installation of new access points usually occurs during vacation periods or in between semesters when the campus is not so heavily populated.

WLAN controllers manage the multiple access points within a facility while also protecting network security and delivering roaming services for users. Installing pairs of wireless controllers provides a backup if the primary controller fails, which helps to avoid a WLAN outage. WLAN controller architectures can separate traffic from control signaling to boost performance and to avoid the controller from becoming a traffic bottleneck. In addition, external wireless antennas for both indoor and outdoor applications can be installed where needed to improve coverage and performance by boosting and focusing the access point's signal energy while allowing for its convenient placement and installation.

Wireless management software is another important solution to bring into your network management tool set. This solution allows you to monitor, manage, troubleshoot and report on all access points and wireless controllers. It can also help you detect wireless security threats and resolve issues of signal

According to the CDE survey, K-20 education institutions are making investments to their network infrastructures:

54%

of respondents plan on modernizing their network by investing in Local Area Network (LAN) equipment.

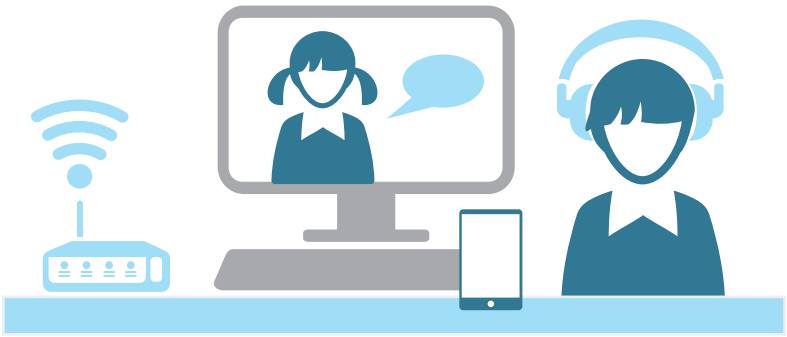
40%

plan on modernizing their network by investing in Wide Area Network (WAN) equipment.

72%

are investing in ways to increase connectivity speed/bandwidth.

With the right tools, power users can be monitored and segmented into a user-type category that puts limits on their broadband consumption and/or reroutes them onto an area of the network that would not interfere with other passive users, thus making everyone's online experience pleasant and uninterrupted.



interference and poor coverage — and send an alert of a potential problem before users are impacted. A solution that integrates easily with your overall network management system will help to reduce operational costs and simplify management tasks.[13]

Implementing Traffic Management

In some cases, IT departments can avoid more investment in relatively expensive network and bandwidth upgrades by incorporating tools that examine and measure user bandwidth consumption across campus. These tools provide the ability to subsequently segment and/or prioritize certain types of traffic.

For example, a "power user" at a college or university is often a residential student who arrives to his dorm room with a smartphone, laptop and tablet that connect to the institution's wireless network along with a gaming console that he plugs into his room's Ethernet port. This power user eats up extraordinary amounts of bandwidth by playing games online and consistently streaming rich media content over his Wi-Fi-enabled devices, such as YouTube videos and Netflix movies on a regular basis.

While the power user consumes the pipeline, his roommate, a relatively passive user who might be using the same shared network passing through the same access point, is having trouble doing a simple Web-based search or getting logged into the learning management system for an essay he has to compose for tomorrow's English assignment deadline.

With the right tools, the power user can be monitored and segmented into a user-type category that puts limits on his broadband consumption and/or reroutes him onto an area of the network that would not interfere with the other passive user, thus making everyone's online experience pleasant and uninterrupted. Alternatively, this segmentation can be done not just by user type but by content type. Netflix, games, social media sites, etc., can be restricted or throttled to a slower speed during peak times to free up bandwidth for more educational applications. The institution can also charge the power-using student an additional technology fee for increased connectivity permissions.

These types of services fall under the banner of "traffic management" that integrate with different forms of authentications and identify user names and roles (teacher or student or researcher, for instance) and then provision bandwidth, controlling and managing the content that is most appropriate for any particular user, explains Trevor Failor, VP of North American Channels at Procera Networks.[14]

In another scenario, an innovative high school teacher may use technology in the classroom by distributing school-purchased, classroom-only tablets to the students in her freshman biology class. The content these students access during class on their tablets includes high-definition videos and sophisticated electronic simulations that take up significant bandwidth. With traffic management tools, the high school teacher in this scenario is able to dynamically deliver videos at a relatively

higher tier of bandwidth than what's available to other classrooms throughout the building that are not in need of such connectivity. The teacher also has the capability to ensure that these students get access to only those online materials that she deems relevant to her instructional methods, so the students do not have unfettered access.

Another traffic management strategy entails installing "high-gain" antennas that can maximize an existing or new router's signal strength. New Wi-Fi antenna-oriented systems can maneuver radio frequency signals around possible interferences to eliminate Wi-Fi dead spots while increasing the range and performance of Wi-Fi networks. In short, these antenna-oriented systems automatically enable Wi-Fi and can help it reach farther and improve reliability.[15]

Routers with high-gain antennas and embedded software can allow for multiple devices to operate effectively beneath one access point. For example, an access point that may have an average of three devices per user may not have a problem if the appropriate antenna technology was installed.[16]

Ensuring Network Security

Security is critical when building a strong Wi-Fi infrastructure. As more data flows over the network, the need to protect sensitive or personal information becomes more important. Users want authorized access to resources they need, but it is also critical to keep unauthorized users off the network — education networks are increasingly becoming the targets of hackers. According to Mark Priscaro with Ruckus Wireless, "Wireless networks are actually incredibly secure. If you have WPA2 installed and you do the due diligence of changing the password once every three months, it is a very difficult network to break into."[17] No matter how secure your wireless network is though, there are always smart decisions you can make to stay on top of network security.

One aspect of wireless security involves protecting the wireless network, the traffic it carries

THE WIRED WAY

The buzz recently is all about mobility and preparing your campuses to support wirelessly connected students, faculty and staff. This has been a consuming activity for network administrators throughout academia for the last few years — as it should. But while leaders are improving access, getting greater density in coverage and hardening wireless networks from improper access, they should not forget about the real campus backbone — the wired campus network.

All the heavy lifting and support on most campuses is still being done over fiber, coax and twisted pair. Access to other campuses or schools, the cloud or Internet services pass through high-bandwidth pipes that must meet the highest levels of security and availability. Therefore, network resiliency and disaster recovery plans begin with a sound Wide Area Network (WAN) solution that is easily managed and designed to protect the network from vulnerabilities before anyone experiences a failure.

Likewise, the campus Local Area Network (LAN) infrastructure not only connects services at the data center, but provides the building-level and campus-level connectivity onto which wireless access points, directly connected PCs, video devices, servers, virtual desktop infrastructure (VDI) devices and other computers attach. A well-functioning campus will make sure its wired network infrastructure is sound, serviced and well managed.

and its connected devices from electronic snooping, attacks and access to inappropriate content. Solutions can include encryption features on WLAN equipment and user devices. Content filtering and application controls on institution-owned devices can also provide protective measures.

The wired network also needs to be protected from unauthorized access via the WLAN. Wireless intrusion detection and prevention are essential capabilities for addressing this challenge.

Finally, education institutions need to authenticate all users and devices that want to access wireless services. Advanced network access control solutions automatically scan devices for threats, identify each connected device, and then provide access depending on the device and role of the user. To help identify user roles and access, many institutions are implementing identity and access management strategies. An identity management system centrally manages network access based on information in existing user directories.

"Identity management is probably one of the most critical pieces of our future."

Laura Patterson, CIO and Associate VP, University of Michigan

"Identity management is probably one of the most critical pieces of our future," says Laura Patterson, CIO and associate VP at the University of Michigan. "We want our identity management system to be smart enough, so that when someone attaches to the network, we know who they are and which of our services they should immediately have access to. We need intelligent identity management to make the positioning of services easier and to be sure that we have the right security on the right services."[18]

COLORADO SCHOOL DISTRICT BUILDS ROCK-SOLID WI-FI SOLUTION

St. Vrain Valley Schools in Longmont, Colo., operates 45 schools that consume over 3.7 million square feet of space. Its computing environment consists of approximately 10,000 networked devices, a mix of traditional computers and thin clients. In addition, St. Vrain supports hundreds of tablets and smartphones.

When it became clear that building a reliable Wi-Fi network was imperative for St. Vrain to meet the growing needs of its faculty and students to offer the new generation of online teaching and learning environments, a technology review committee was convened to begin a rigorous evaluation process of potential wireless systems. Key requirements included strong client connectivity, multimedia support, dealing with high-volume concurrent clients, simple configuration and deployment, remotely monitoring, management and reporting, and the ability to adapt to changing conditions and client orientation.

Watch the video at: www.ruckuswireless.com/asset/watch/360

After an exhaustive evaluation, St. Vrain began

Additional security measures to consider include:

- Do you have end-to-end security capabilities across the wired and wireless networks?
- Do you have the ability to create and manage network access control lists and policies?
- Do you block access to selected applications, such as music download sites, in order to limit exposure to security and liability risks? Sometimes called "blacklisting," this measure also avoids the traffic load generated by applications that use large amounts of bandwidth, but aren't essential for student learning.
- Do you have an acceptable use policy? An acceptable use policy defines how users can use your school's network and computing resources, as well as restrictions on content that users can access or publish via the Web, email and social networks.

Additional Wi-Fi Considerations

Following are some recommendations for educators to take into consideration when charting a course of action for developing effective WLANs for teaching, learning and operations:

1. Basic connectivity for conducting simple research for term papers, communicating by email and updating announcements (relatively low-bandwidth activities) requires a minimum of 10 Kbps student/staff broadband connection.

Utilizing online educational tools and resources such as accessing more dynamic content over the Internet with a laptop or mobile device, collaborating with peers, downloading videos, and receiving and posting assignments on the school's learning management system requires a minimum of a 50 Kbps student/staff broadband connection.

Exploiting a fuller potential of connectivity to include accessing rich, multimedia-enhanced content, accessing e-textbooks, regularly streaming media, going on virtual field trips, and conducting uninterrupted online formative and summative assessments requires a minimum of 100 Kbps student/staff broadband connection.

testing the new system, implemented in partnership with an outside carrier. "Our main objective was to break the product and see where and when those breaks occurred," says St. Vrain CIO Joe McBreen.

For testing, St. Vrain selected a location in one of the district's middle schools that was known to be unfriendly to radio frequency signals. Testers placed 30 802.11n laptops in a classroom running through a battery of association, user authentication and performance tests. Once completed, St. Vrain began streaming 102 Mbps video data streams simultaneously from each laptop.

"We had 60 concurrent devices streaming video from two classrooms and couldn't break this thing, so we began pulling out ... anything we could get a hold of to make it fail," says McBreen. "Ultimately we had 78 devices pulling traffic off a single access point, and it wouldn't fail. That's when we knew we'd made the right decision."

St. Vrain then partnered with an integrator who performed site surveys, configured the network and installed the carrier's access points. Once deployed, the access points automatically configured over the network, thereby reducing deployment cost and time. St. Vrain was also able to have discrete WLANs in each of its schools, but have all the LANs under the control of a centralized Wi-Fi management system.

With the work of designing and implementing its new wireless network now complete, St. Vrain can focus on educating students. "With a rock-solid Wi-Fi infrastructure in place, we can now get creative and focus on delivering more applications and content to teachers and students everywhere," says McBreen.[19]

2. Internal WAN connections from the district to each school and among schools within the district should be at least 1 Gbps per 1,000 students/staff by 2014-15 and at least 10 Gbps per 1,000 students/staff by 2017-18.[20]

3. Smart WLAN architecture addresses the aforementioned requirements and applications, as well as user behavior by combining centralized security and management with system-wide air traffic coordination and control.[21]

4. When committing to the deployment of advanced wireless technology, network administrators must ensure that every piece of the WLAN is both reliable and compatible with the other pieces of the network. The best way to ensure compatibility is to find an equipment provider offering a broad range of wired and wireless networking gear.[22] Or if you don't want to tie yourself to one vendor, make sure you acquire equipment that follows standards and/or open standards so you keep your options open. ■

YORKVILLE SCHOOL DISTRICT 115 BOOSTS WI-FI AND PREPARES FOR THE FUTURE

When Ryan Adkins took on the position of director of technology for Yorkville School District 115 in Illinois in July 2011, he found some serious challenges that needed to be dealt with immediately. One was that the district did not have a wireless infrastructure other than a single connection for the district's board of directors who were using tablets at their board meetings.

"We wanted to build a wireless infrastructure so students could bring their own devices," Adkins says. "Our plans called for our community of learners to have consistent opportunities to be technologically empowered citizens." In line with such plans was the need to build out new access points and switches to increase the overall bandwidth throughout the entire district of nine schools.

"With something that affects this many people, students and buildings, I needed to go higher than our knowledge base on staff here," Adkins says.

To find the right solution, Adkins decided to partner with a third-party vendor for guidance on the process. "I sat down with the representative and said we need to discuss what steps to put in place, because I was not sure how much it would cost and how much we would be able to do at one time," says Adkins.

The move paid off. About one year later, in the summer of 2012, Yorkville District 115 had a sophisticated wireless infrastructure solidly in place along with more than enough bandwidth to serve the district's needs.

"We have wireless in all of our buildings, and we are currently in a development phase to write all the policies so that students can start bringing in their tablets and smartphones to use for educational purposes," says Adkins.

"We built in all the engineering costs, all the project management costs, all of the on-site work into the lease," he adds. "We upped our bandwidth. We used to have 100 megabytes per building and we had 40 megabytes to the Internet. Right now we have 500 megabytes between buildings and 100 megabytes to the Internet, and we will grow that over the next five years. We built the network to handle the upgrade in bandwidth. Our infrastructure is not going to hold us back from what's available out there."

With the right infrastructure now in place, Adkins is confident that the district will be able to handle whatever lies ahead in education's digital realm.[23]

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RYAN ADKINS, DIRECTOR OF TECHNOLOGY, YORKVILLE SCHOOL DISTRICT 115, ILLINOIS

"The personal cloud vision is truly all about a personal experience. **It is allowing people to bring in devices and leverage applications and information resources** that otherwise were not available and were not created by the school districts. With that it is absolutely germane for the network infrastructure to be able to automatically provision for these devices."

GREG KOVICH, DIRECTOR OF EDUCATION, SALES & MARKETING NORTH AMERICA, ALCATEL-LUCENT

"You want to keep kids safe, and there is a lot of confusion out there, especially with mobile devices and BYOD. What are they legally and morally obligated to do? It varies from location to location. **There are conservative communities and there are liberal communities who want more openness."**

ROB CHAMBERS, VICE PRESIDENT, PRODUCT DEVELOPMENT, LIGHTSPEED SYSTEMS

"A very high percentage of schools — 94 percent — have moved to some form of online student assessment and testing. Not so high is the network capability to handle it — 42.9 percent said they could handle it. In terms of flipped classrooms — 21 percent are doing it — another 22 percent said they plan to try it soon — but only 13 percent of schools said that their networks could handle the demand of flipped classrooms."

BOB NILSSON, DIRECTOR OF VERTICAL SOLUTIONS MARKETING, ENTERASYS

"Software-defined networking is helping to streamline cloud computing. From the networking perspective, you have to have the compute and you have to have the networking. SDN supports the new cloud computing. Schools are moving to the cloud for email and video and voice. The intelligent network supplies all the services based on the demand."

TAE HWANG, SOLUTIONS ARCHITECT, PUBLIC SECTOR, CISCO

"Educational technology today is not just about students having their own devices — it involves enabling them as well as educators with powerful, mobile collaboration tools. **It's about building an ecosystem that fosters personalized learning, community and connectedness."**

BEN KRUSE, LEAD MANAGER, EDUCATION MARKETING, AT&T

"Video is quickly becoming a necessity — not just a nice to have. As video chat and video-conferencing tools have proliferated across education; faculty, staff and students expect to be able to see each other when they collaborate. Likewise, tools like YouTube have brought to a head the power of video on demand in learning. **Higher education and K-12 alike are quickly embracing live video and video on demand to support this highly interactive and collaborative environment where the students are extremely engaged.** To create this environment requires an infrastructure and network in place that supports unified communications of voice, video and data ... one that works via open standards-based interoperability with communications, business and education applications from hundreds of vendors."

MARCI POWELL, GLOBAL DIRECTOR, POLYCOM

PREPARING FOR IMPACT

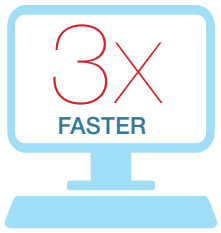
Smart Infrastructure Strategies to Manage Education Trends

With a strong Wi-Fi infrastructure as part of your foundation, it's important to now look at each of the aforementioned trends individually and identify how they will not only impact your infrastructure, but what smart strategies and solutions you can be implementing to prepare for them.

Addressing Device Adoption: Implementing BYOD and 1:1 Computing

The two most popular strategies for ensuring students, instructors and staff have access to devices in K-20 education are 1:1 computing (one device for every student, typically institution owned) and bring your own device (BYOD), where students and faculty bring their personal devices on campus for educational use.

Many IT professionals agree that 1:1 is ultimately the easiest route to choose — when all users have the same device, there are less compatibility issues and maintenance is less complicated for IT. Due to the upfront hardware costs with this model, however, many institutions are implementing less-expensive BYOD strategies as a kind of testing ground to get devices into student and faculty hands. Whatever route is chosen, there are smart infrastructure decisions and considerations that can ease adoption.



To prepare for its bring your own technology initiative, Forsyth County Schools in Georgia doubled bandwidth, from 1 MB per second to 2, and nearly tripled Internet access (from 500 MB to 1.3 GB). It also upgraded to the N wireless standard, at a cost of $1.4 million.

Managing Devices

To help simplify device management in both scenarios, Jaime Casap, global education evangelist at Google, says that going with one device, or several devices that all have the same capabilities and can all run the same applications is a logical step in the right direction.[24]

Salah Nassar, senior manager of enterprise product marketing at Ruckus Wireless, stresses that the key is to keep things "absolutely simple."[25]

Some experts advocate for a solution that requires device registration, which allows IT administrators to get a big picture view of all of the devices on the network. Self-service portals can allow users to register their own devices; and automatic device tracking and auditing enable IT to link devices to users and IP activity for security, compliance and reporting.

The easiest-to-manage solutions require zero or very limited IT interaction to get users onboarded as quickly as possible to the network. An example of this process would go something like this:

1. Users connect to a provisioning service set identifier (SSID) and are directed to an onboarding portal
2. Users enter domain credentials which are verified against a user database
3. The user's role assignment and permissions are automatically determined based on authentication
4. The device is auto-provisioned with a dynamic pre-shared key
5. Devices re-connect on a secure WLAN, receiving network permissions based on their role

Improving Network Performance

When assessing the IT infrastructure and preparing for BYOD or 1:1 implementation, planners

need to also evaluate Internet bandwidth. To prepare for its bring your own technology initiative, Forsyth County Schools in Georgia doubled bandwidth, from 1 MB per second to 2, and nearly tripled Internet access (from 500 MB to 1.3 GB). It also upgraded to the N wireless standard, at a cost of $1.4 million.[26] Similarly, when a Pennsylvania school district implemented a BYOD policy, it increased bandwidth as well. Public schools in Red Lion, Pa., now have access to a high-capacity WAN. "The bandwidth on the WAN will no longer be the limiting factor for performance," says Jared Mader, director of technology services for Red Lion Area School District.[27]

Some additional considerations:

- Do you have an estimate of the maximum number of devices that might be used at any given time?
- What apps do you anticipate running? Will they include multimedia files, especially streaming video?
- Is the total bandwidth on your Internet connection adequate without causing noticeable slowdowns for users?
- Do you have a redundant and resilient network available so that teaching can continue without interruption if there's a single point of network failure?
- Is it time to refresh capabilities for managing endpoints, monitoring signal strength and maintaining security on the wireless network?
- Have you reviewed mobile device management solutions, which allow you to see and control all devices connected to your network?

Los Angeles Unified School District (LAUSD) in California knows a thing or two about what it takes to prepare for a major device onslaught. Last summer, the district announced its goal of supplying every student with a tablet or other device within the next few years. In January 2013, an LAUSD Bond Oversight Committee recommended that $50 million in bond funds be allocated to provide LAUSD students with personal computing devices to support instruction and the transition

SOME PRACTICAL ADVICE FROM LAUSD'S CHIEF TECHNOLOGY DIRECTOR THEMY SPARANGIS

- Have all the important divisions of the district be involved in the decision-making process, such as — in addition to faculty and administrators — your purchasing group and legal group. In other words, make it a collective effort.
- Ensure devices are durable and that content is accessible and easy to use.
- Explore methods to come in and out of Wi-Fi without hindering instructional materials by having content locally held on the tablet and then updating the content as needed. This kind of practice does not require a persistent Wi-Fi connection — only a good Wi-Fi connection on a regular basis.
- Support teachers and ensure they have, at the very least, basic computer literacy skills that would enable them to be the first line of defense when something goes wrong on a minor scale. For example, if an online connection goes down, the instructor should have a ready list of suggestions to offer as opposed to having to refer students to a technical support person.
- Ensure that all users know the proper rules of Internet etiquette, also known as "netiquette."
- Be sure to test out how these devices and instructional content will ultimately work within a testing environment, especially with the CCSS online assessments on the near horizon.
- Local, site-based technical support is needed to assure minimal downtime, quick response to issues and day-to-day maintenance of the technology infrastructure.[28]

to Common Core. If approved by the LAUSD Board of Education, thousands of students at 47 schools will receive the devices by the beginning of the 2013-14 school year as part of the first phase. As noted in this recommendation, the plan is to initially invest these dollars in procuring devices for 30,000 students "in addition to planning, procurement activities, staffing and initial implementation of infrastructure."[29] See some advice for preparation from LAUSD's Chief Technology Director Themy Sparangis on page 17.

Keeping Pace with Evolving Learning Environments

As mentioned earlier in this Special Report, advances in technology have broken down the physical barriers to a traditional classroom, enabling learning to take place 24/7 and from a place of the student's choosing. Because of this, K-20 institutions need to not only ensure access to educational resources on campus, but need to expand that access to when students and faculty are off school premises — whether they are off campus because of a hybrid or online learning environment, or if they simply wish to work on assignments at home, but access campus resources. Certain IT infrastructure solutions can make this a reality.

Virtualizing Desktops

Both higher education and K-12 institutions can use virtual desktops to give students access to the applications and data they need from any device, anywhere and at any time — a boon to online learning as well as a potential cost saver.

Due to virtualization, old and/or underutilized desktop computers in desperate need for replacement are now being transformed into reliable workstations connected to the Internet or a private network that gives students and faculty access to the applications and resources they need. In other words, access can be provided regardless of the age of a computer or laptop through the utilization of desktop virtualization. You may consider it a form of IT recycling on campus.

Virtual desktops also make maintenance much easier; IT can change applications at the server level, which then can be seen instantly by any

1:1 ON A BUDGET

FLICKR/DEVON CHRISTOPHER ADAMS

Pomona Unified School District in California wanted to improve principal and teacher effectiveness by providing mobile devices, but faced budget challenges. To overcome this challenge, the district was able to partner with a wireless carrier to make better use of the district's technology dollars by leveraging discounts under relevant state (California Teleconnect Fund) and federal programs.

After consultations, the district ultimately implemented a cost-effective solution that was based on the deployment of touchscreen tablets connected via the carrier's extensive mobile broadband network. Tablets were provided to 87 site administrators, who used them to run applications to conduct classroom observations and offer timely and meaningful feedback. The tablet solution was then rolled out to 600 teachers, who used a course management system to track materials and student work, manage grading and collaborate with colleagues.

The impact and cost-effectiveness of the deployment was so great, district leaders are discussing expanding it to provide mobile devices such as netbooks, notebooks or tablets to students of a high-tech charter school.[30]

machine accessing the virtual desktop (as opposed to going around to each machine and manually updating software or making other changes). Districts can make do with less expensive thin clients to access programs. Or, students can use their own devices, whether they are PCs, tablets, laptops or other mobile tools.[31] Twenty-two percent of respondents to the CDE survey are currently implementing desktop virtualization.

Since 2010, the University of Texas – Pan American (UTPA) has used a virtual desktop infrastructure (VDI) environment to install engineering, mathematics and statistical analysis applications on virtual desktops along with standard office software. Some applications were licensed on a campus-wide basis, while others were licensed for 50 or 100 virtual desktops. Since a majority of the university's 19,000 students are commuters, the main motivator behind the VDI initiative was to save students money by making it to where they did not have to travel to the university lab to use the software they needed.

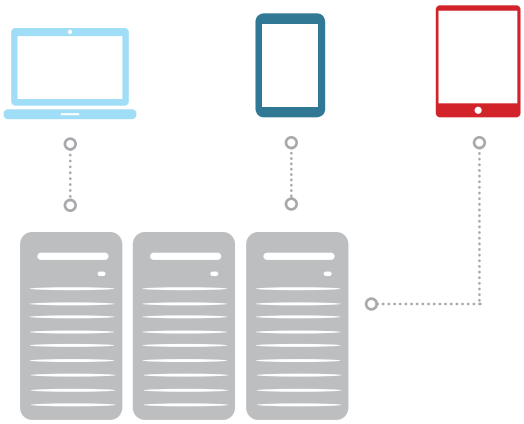
Each semester, usage has increased with students accessing the virtual desktops from a wide variety of devices from off campus. In addition to saving students money, the campus has also realized cost savings. In effect, the university's computer lab is now virtually open 24/7. Two years ago, the computer labs were open from 8 a.m. to 7 p.m., Sunday through Friday, with Saturday hours being from 8 a.m. to 5 p.m. The virtual computer labs allowed UTPA to shorten the operating hours, saving the university money on power and staff costs.[32]

Before adopting desktop virtualization, consider the following:

- Do you have challenges with desktop management, software deployment and software compatibility, or are your customers clamoring to bring in their own devices?
- Desktop virtualization is about true value of ownership, not total cost of ownership (TVO vs. TCO). It can cost more, but the value is exponential. Do you need the added value, and are you prepared to commit the funding to provide that value for your students and staff?
- A virtualization project is not like installing a new application. It can take many months or years depending on the size of the project. Are you prepared to make the time and resource commitment to see the project through to completion?
- Do you have a robust network in place, or are you prepared to build the network topology necessary to support a virtualized environment?
- Does the value of access outweigh the potential minor changes and cultural shifts that are inevitable with this new technology?
- Are you committed to bring in resources with the skills, knowledge and experience to ensure a successful implementation?[33]

Embracing Cloud Computing

Cloud computing is increasingly being adopted by K-20 education institutions as a way to cost-effectively provide 24/7 access to learning resources both on and off campus, from any Internet-enabled device. It allows education leaders to support evolving learning environments with limited resources. For instance, 64 percent of respondents to the CDE survey have plans to adopt cloud-based email applications in the near future. This saves



22%

of respondents to the CDE survey are currently implementing desktop virtualization.

The CDE survey showed that the majority of respondents were considering cloud implementations in the near future:

64%

of respondents have plans to adopt cloud-based email applications.

68%

have plans to adopt cloud-based productivity applications (calendaring, IM, etc.).

59%

are looking to adopt cloud-based learning management systems.

institutions the upfront capital costs and ongoing maintenance costs of providing their own email application.

Another benefit of cloud computing is its ability to accommodate diverse demands that would be difficult for a single institution to handle effectively. The cloud provides elasticity and can stretch temporarily to meet high demand — or retract when demand is low. Additionally, cloud providers can typically take over the management of upgrades and backup and disaster recovery.

For instance, cloud computing can sometimes be used to support network services by providing facilities to maintain and control the network such as cloud-enabled wireless access points and switching. Or cloud storage solutions allow institutions to pay for and add storage only when they need it, which lifts the burden off of IT staff to regularly monitor and manage storage volumes. These types of cloud solutions are particularly attractive to smaller school districts or colleges that don't have the IT resources to manage infrastructure.

Throughout K-20 education, examples of utilizing cloud services are practically endless. Any teacher can go to wikispaces, for example, and create an online space for students to share assignments, images, links, videos and more.[34] At UMass Lowell, wikispaces is used in computer science classes where faculty members post weekly discussions for students to answer and upload assignments to their own unique Web pages, all of which facilitates collaborative learning.[35] Many institutions are even moving their whole learning management system (LMS) to the cloud — 59 percent of CDE survey respondents are looking to adopt cloud-based LMSs.

However, all of these benefits do not mean that educators should automatically jump into the cloud without careful consideration. Cloud computing can raise concerns about privacy, security and data integrity, and other issues. Because of this, before adopting cloud computing EDUCAUSE recommends education leaders ask the following questions:

- What are the provider's security procedures?
- How frequent and reliable are the provider's backups and its recoverability of data processes?
- Is there a contingency plan just in case the provider goes out of business or happens to merge with another company?
- What kind of state and/or local regulations must you be aware of regarding where data is stored? How do Health Insurance Portability and Accountability Act (HIPAA) and Family Educational Rights and Privacy Act (FERPA) regulations play into the adoption of cloud services?
- Is the provider's service level agreement (SLA) sufficient to meet the institution's requirements?
- What are the specific parameters overall that relate to risk assessment and tolerance?
- Do you have a policy that includes the who, what, where, when and how of oversight responsibilities?[36]

Preparing for Online Assessments

The new Common Core State Standards (CCSS) online assessments will use computer scoring and expert graders with an estimated results turnaround of about two weeks. Digital Learning Now refers to this shift to online assessments in tandem with the rapid increase of device adoption and top-notch digitized instructional materials as "an unprecedented opportunity to fundamentally shift the education system to personalize learning around the individual needs of every student. … States and districts must act now."[37]

For many schools, the two biggest impediments to meeting the CCSS online assessment mandates are ensuring that there is enough bandwidth to accommodate hundreds — or thousands — of students accessing

the network at the same time, and providing enough devices for students to complete online testing.

Ensuring Access to the Network

To ensure students can access the network simultaneously, schools will need to increase their current levels of network capacity in both wire line and wireless access. Bandwidth will have to be increased to accommodate the relatively large numbers of students taking these tests simultaneously, with some educators saying that a T1 connection should be sufficient for testing of 64 students and an installation of a local cache service to reduce bandwidth requirements to enable up to 1,500 simultaneous online test takers.[38]

Two national assessment consortia, the Partnership for Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium (Smarter Balanced), are spearheading similar approaches for this new generation of online assessment systems and providing guidance to schools and districts.

Smarter Balanced and PARCC teamed up to create a tool intended to aid states and districts in taking a snapshot of their mobile device environment, as well as their overall technological bandwidth. The tool, dubbed the Technology Readiness Tool, went out to states in March 2012 and hit districts later in the summer.[39]

Additionally, in April 2012, Smarter Balanced and PARCC issued guidance designed to inform schools and districts as they make annual instructional technology purchases. The guidelines include hardware and operating system specifications covering the vast majority of commercially available computers and tablets. Specifications common to both consortia include:

Hardware

- 1 GHz or faster processor
- 1 GB of RAM or greater memory
- 9.5 inch (10 inch class) or greater screen size
- 1024 x 768 or better screen resolution
- Mechanical keyboards must be available unless students use alternative input devices as part of their classroom instruction.
- The device must have the administrative tools and capabilities to temporarily disable features, functionalities and applications that could present a security risk during test administration.

Operating System

- Windows 7
- Mach 10.7
- Linux (Ubuntu 11.10, Fedora 16)
- Chrome OS
- Apple iOS
- Android 4.0

Networking

- Wired or wireless Internet connection
- Must connect to the Internet with approximately 10 to 20 Kbps available per student to be tested simultaneously

Device Type

- Desktops, laptops, netbooks, thin clients and tablets that meet the hardware, operating system and networking specifications[40,41]

Ensuring Access to Devices

BYOD and 1:1 policies, as mentioned previously in this report, can help solve the challenges of providing devices. Schools that have implemented these policies will be in a good place to address the CCSS mandates. Additionally, schools can look to desktop virtualization technology to overcome this challenge, as Scotland County Schools in North Carolina did (although it's important to note that according to guidelines, each computer operating in a thin client environment must meet or exceed minimum hardware specifications, as well as bandwidth and security requirements).

To meet requirements for online assessments, the district rolled out desktop virtualization to

Some recommend that a T1 connection should be sufficient for a simultaneous testing of 64 students and an installation of a local cache service to reduce bandwidth requirements to enable up to 1,500 simultaneous online test takers.

SUPPORTING ADVANCED COMPUTING WITH SOFTWARE-DEFINED NETWORKING

An additional trend becoming prevalent at higher education and research institutions is the need to support users who require access to emerging types of applications, advanced levels of collaboration and increasing speeds of data flow. To address this trend and meet these needs, education institutions are starting to look toward software-defined networking (SDN) and OpenFlow standards. While not entirely new, the latest developments in SDN and OpenFlow could bring unprecedented efficiencies of scale and cost savings relative to network management.

What exactly are these new concepts? SDN "enables direct programmatic control of the network, coupled with end-user-driven applications and needs, enabling operators to efficiently use their network and operational resources,"[42] while OpenFlow is an "open standard that enables researchers to run experimental protocol in campus networks. [It] provides standard hook for researchers to run experiments without exposing internal working of vendor devices."[43]

At Clemson University, an SDN team has been created under the leadership of Daniel Schmiedt, executive director of network services and telecommunications, in collaboration with Clemson's School of Computing and with support from a National Science Foundation (NSF) grant. This team has already implemented a data analysis network through SDN/OpenFlow technologies and is currently working on broadly improving network performance in 20 buildings across campus to connect with part of Clemson's high-performance computing cluster at 100 Gigabit connectivity.

"We are used to operating in a paradigm where you literally take data and pour it into a big network, and you expect the network to forward the data and move it out into the right place," says Schmiedt. "But we are shifting into a world where you can make SDN do just that. I think the possibilities for true innovation exist outside of that original paradigm."[44]

According to Schmiedt, in addition to partnering with a vendor that has a roadmap going in this direction, IT leaders at universities need to collaborate with faculty and staff from their computer science and computer engineering departments. "You need to build a relationship with your academic side," he says. "You will be sitting on a powder keg of possibilities if you can get collaboration between your professional networking staff and the academic part of your university."[45]

The University of Southern California's Information Services Institute (ISI) is another university taking advantage of SDN. ISI's research and tests of advanced bandwidth-intensive applications, such as grid computing, artificial intelligence and embedded programming are helping to shape technology's future.

Because of ISI's complex environment of Linux, Macintosh and Windows-based clients, the research institute must have a network based on open standards with interoperable devices. With a constantly evolving environment, ISI needed network equipment that would easily adapt to equipment, user and application changes. To do this, ISI elected to implement a SDN that can easily adapt and accommodate many different types and volumes of traffic.

"We don't know what people will throw at us in terms of projects

MICHELANGELO LORETI

Clemson University, with the help of SDN and OpenFlow technologies, is working on broadly improving network performance across 20 buildings on campus to connect with part of Clemson's high-performance computing cluster at 100 Gigabit connectivity.

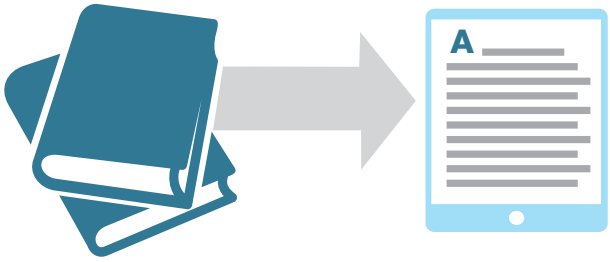
or equipment," says Richard Nelson, director of computing at ISI. "In a research environment you are exploring the frontiers, and you must be able to respond quickly. A proprietary device may prevent you from meeting your customers' needs."

ISI can now easily support bandwidth-intensive applications, such as grid clustering, application modeling, video streaming and other research projects. And it can continue to scale into the future as its needs change.[46]

In an Open Network Foundation report about SDN and OpenFlow, titled "The New Norm of Networks," it's explained how these new technologies are transforming network backbones into rich service-delivery platforms. "By decoupling the network control and data planes, OpenFlow-based SDN architecture abstracts the underlying infrastructure from the applications that use it, allowing the network to become as programmable and manageable at scale as the computer infrastructure that it increasingly resembles." The report goes on to say that SDN adoption "can improve network manageability, scalability and agility."[47]

According to David Meyer, CTO and chief scientist at Brocade, SDN is an example of how the right programmable and open software can help bring down costs and solve some of education's greatest IT challenges. "The development of such sophisticated open software is a trend that has great potential on many levels. Software development basically improves hardware; it learns behaviors, optimizes services and helps to improve our lives," says Meyer.[48]

The University of Michigan is digitizing more than 10 million texts (books, journals and periodicals) from a group of 12 universities and making them available online as part of the Michigan Digitization Project.



every school for a total of 1,400 seats. All students have access to their own thin client terminal, explains Rick DeLaunay, director of technology. "One server or desktop computer runs an entire classroom, and in four years when it's time for a refresh, it will cost less than $1,100 to upgrade an entire room."[49]

Pearson's "Considerations for Next-Generation Assessments," offers a roadmap for schools as the deadline to 2014 approaches. Some key questions the report proposes districts ask themselves regarding infrastructure include:

- How many computers within the district or at each school meet technology requirements for an online assessment and can also be made available for student use during assessments?
- Given a specified window for testing, are there enough computers and lab times for all students to complete testing?
- Is enough network bandwidth available to support the content and number of students testing simultaneously? Do schools already have proxy-based or other mechanisms to reduce the demands on bandwidth?
- How often do schools refresh or replace their existing computers and other hardware?
- Does the school have future technology implementation plans that could materially impact any of the above questions (e.g., a school that may intend to replace computers of one particular operating system with mobile handheld computers using a different operating system)?
- What other infrastructure or logistical issues may need to be assessed at the local level (such as the need for electrical power upgrades or other location-specific challenges)?[50]

For many school districts, meeting all the challenges that are coming down due to the CCSS will require the deployment of new partnerships with leading technology vendors in the field. Such partnerships could be limited to only one or a few specific functions or more broadly spread out in a more complete outsourced management scenario.

Betting on Big Data

It seems the whole world has been charmed by the promise of big data — and education is no exception. A recent *Forbes* article asks, "In education, as in many other sectors looking for a quick-fix, big data suddenly promises a new salvation. If we just collect and analyze enough data, isn't the state of education going to improve?"[51]

It appears that it should. According to Darrell M. West, director of the Center for Technology Innovation at the Brookings Institution, "So-called 'big data' make it possible to mine learning information for insights regarding student performance and learning approaches. Rather than rely on periodic test performance, instructors can analyze what students know and what techniques are most effective for each pupil. By focusing on data analytics, teachers can study learning in far more nuanced ways. Online tools enable evaluation of a much wider range of student actions, such as how long they devote to readings, where they get electronic resources, and how quickly they master key concepts."[52]

Big data initiatives in education are also getting backing from the federal government. In March 2012, President Obama announced a $200 million "Big Data Initiative" that was aimed, in part, at improving education. The effort is reaching beyond the

heady domains of scientific research and national security to "transform teaching and learning."[53] This development follows nearly a decade of work and hundreds of millions of dollars of investment into statewide longitudinal data systems.

However, big data initiatives in education are not without their challenges, particularly when it comes to infrastructure. A report by the U.S. Department of Education notes significant costs concerning the collection and storage of data. Moreover, many schools and colleges have legacy data systems that do not interoperate with other systems, such as an institution's learning management system, making it difficult to bring together administrative data with classroom-level data.[54]

For education institutions to realize the promise of big data, they need to make smart infrastructure decisions that allow them to store, capture and easily access it.

Storing Data

With big data, technology infrastructure questions and concerns are frequently related to storage, backup and recovery, and consistent and reliable availability. In fact, education ranks among the top 10 fields in terms of data storage needed, particularly in higher education, where institutions dedicated to research in genomics and other physical sciences are experiencing a particularly acute problem with storing massive amounts of data.[55]

Schools have several storage options, including storage area networks, or SANs, that share space among connected devices; content-addressable systems (CASs) that store data that doesn't change; and network-attached storage systems (NASs), in which access to storage devices is gained through the network.

For example, the University of Michigan (U-M) is digitizing more than 10 million texts (books, journals and periodicals) from a group of 12 universities and making them available online as part of the Michigan Digitization Project. The project includes the creation of a shared digital repository searchable by Google (Google Books handles the actual book digitizing process). U-M is partnering with several other Big Ten universities to eliminate data silos and create a shared pool of storage. U-M opted for a NAS solution with high performance and scalability to handle storage and access demands.[56]

Data storage also can occur in the cloud. Fifty-four percent of the respondents to the CDE survey either already have cloud-based storage or are planning to implement it. One key to choosing data storage management solutions is to make sure they are non-proprietary, so you aren't locked in to particular platforms or vendors.

Some schools may consider outsourcing data storage while others will want to continue direct management.

When looking at data storage solutions, education institutions should consider their requirements. When Columbia University's Center for Computational Biology and Bioinformatics (C2B2) recently redesigned its storage system, those requirements included:

- Performance: Can it handle the size of our data?
- Scalability: Can it accommodate increasing amounts of data?
- Reliability: Does it have redundancy built in? What are the chances of system failures?
- Manageability: Can we deploy and maintain this without adding staff?
- Cost: Is it cost effective now, and in the future?[57]

An institution's needs are going to depend on size and activity — the needs of a small school district are going to drastically differ from the needs of a research university — but these categories of evaluating storage solutions should be relevant regardless of size or type of institution. C2B2 ultimately decided on a scale-out NAS, but education leaders should evaluate their own criteria to determine what approach fits with their needs and plans for the future. ■

THE STARTING LINE TO SMART INFRASTRUCTURE

In this Special Report, we have presented solutions, strategies and considerations to help K-20 education leaders tackle four of the most impactful trends affecting IT infrastructures. The information presented is meant to give you a basis on which to build off of when making smart infrastructure decisions that meet your campus needs now and well into the future.

As Laura Patterson, CIO and associate VP at the University of Michigan, explains, "It's a very challenging time to be in IT. Smart infrastructure is the key, and the services are coming from everywhere. Providers are everywhere. The infrastructure that enables your users to get to the services they want but that also protects their security and enables them to be mobile and enables them to access information anywhere at any time from any device and do it in a way that is pure, is a challenge that everyone faces. But it's an exciting time; it's a great time. ... We are in that type of disruptive change, and it's very much driven by technology, but also technology is the response."[58]

So, use this Special Report as a starting point, understand what the market really offers and be fully aware of all the resources that are available so you can continue to make informed decisions and create meaningful plans on your road to smart infrastructure. ■

RESOURCES

Related to Evolving Learning Environments

The Lumina Foundation
WWW.LUMINAFOUNDATION.ORG/GOAL_2025.HTML

The League for Innovation in Community Colleges
WWW.LEAGUE.ORG

The Instructional Technology Council
WWW.ITCNETWORK.ORG

The Sloan Consortium
HTTP://SLOANCONSORTIUM.ORG/

WICHE Cooperative for Educational Technologies (WCET)
HTTP://WCET.WICHE.EDU

The International Association for K-12 Online Learning (iNACOL)
WWW.INACOL.ORG

Related to Online Assessments

Smarter Balanced Assessment Consortium
WWW.SMARTERBALANCED.ORG

Partnership for Assessment of Readiness for College and Careers
HTTP://PARCCONLINE.ORG

Related to Software-Defined Networking and OpenFlow

Internet 2's "SDN Collaboration Space"
HTTPS://SPACES.INTERNET2.EDU/DISPLAY/SDN/SDN+COLLABORATION+SPACE

The Open Networking Foundation (ONF)
WWW.OPENNETWORKING.ORG

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The IT Infrastructure Imperative

Preparing for transformational technology change in education

THE CLASSROOM EXPERIENCE has moved from static, one-dimensional learning to dynamic, collaborative and interactive learning. Though many factors contribute to this shift, CDW•G knows that technology is playing an integral role in this transformation. Smartphones, digital content, learning management systems and hands-on projects are not only essential to the modern learning experience — they are critical to preparing students for college and beyond.

As school leaders consider expanding the use of technology in the classroom, they also must be mindful that increasing access to classroom technology can overwhelm the existing IT network. More users, devices and wireless access points translate to more data demand on the network. Absent a solid IT infrastructure, classroom technologies may not perform to the fullest, placing added stress on faculty and IT professionals.

According to Learn Now, Lecture Later, a CDW•G survey, 87 percent of IT professionals say they need to upgrade their district's infrastructures to incorporate more technology in the classroom. Based on the report's findings, IT professionals make it clear that most districts need to take another look at infrastructure.

Districts cannot just purchase a set of computing devices and expect transformational technology programs to grow. It is imperative to have a strong IT infrastructure to support the growth of new classroom technology investments. To encourage modern learning experiences districts need to combine the right IT infrastructure with the right classroom technology. Most of us could not imagine our lives without technology, neither can we imagine today's education system without it.

Investment in IT infrastructure is a bridge to improve technology offerings to students. CDW•G recommends these best practices to improve your district's infrastructure:

Prioritize feedback.

When evaluating the IT infrastructure, it is crucial to secure feedback from all users — administration, faculty, students and IT staff. Districts can then develop a clear understanding of top priorities and components that need updating.

Use your partners.

In the initial planning stage, institutions should look to their IT vendors to provide guidance on the investment, budget, timeline and potential pitfalls of implementation.

Offer professional development.

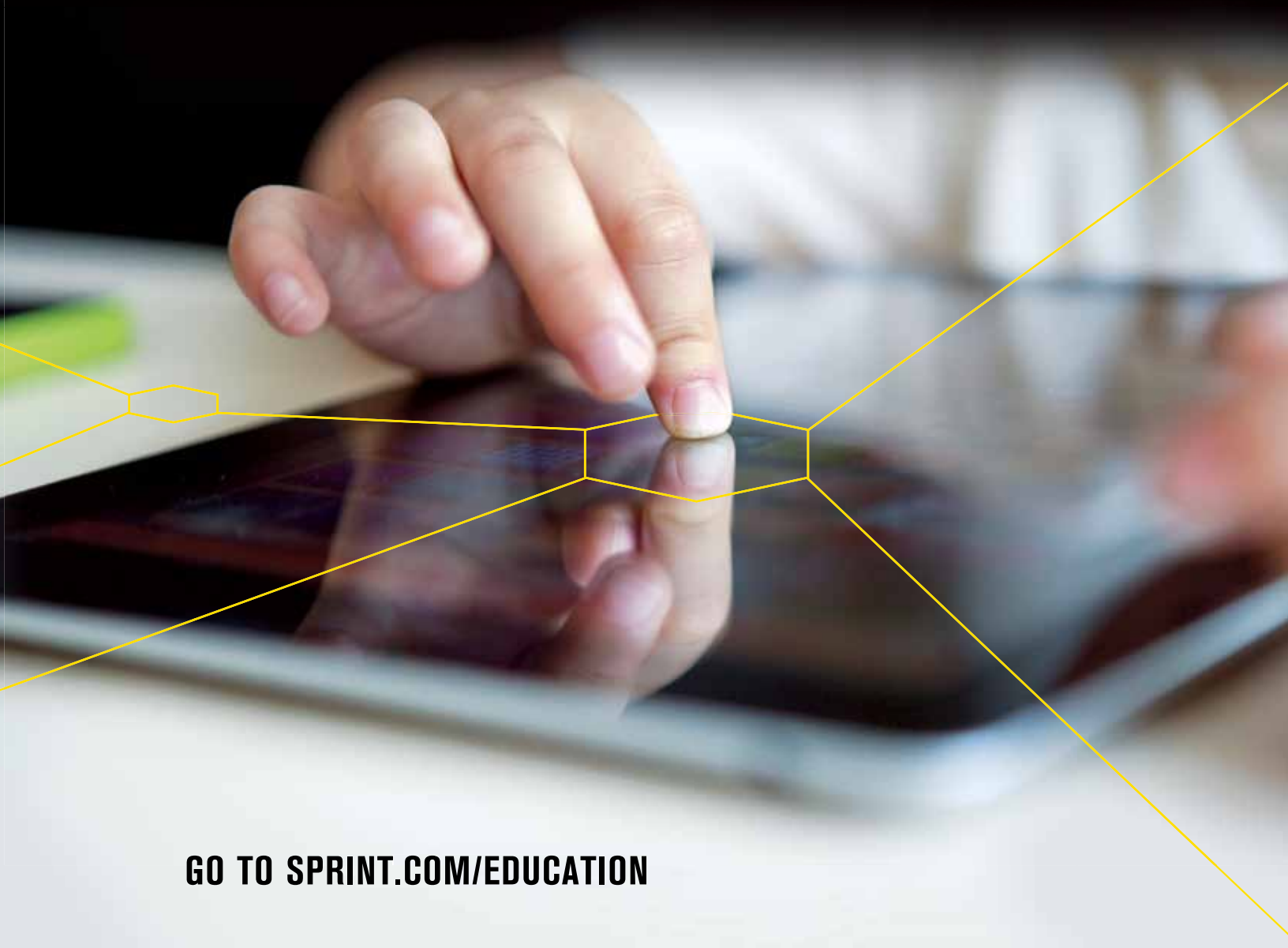
It is important to provide professional development to faculty. Faculty must feel supported and be comfortable with the shift in technology or districts may find that technology integration and adoption will be slower than expected.

Test and measure.

After implementation, it is vital that districts focus on testing and metrics to quantify how their networks are improving.

Get your school

WORKING AS ONE.



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Solutions for Education

Getting a **Better Connection** at School

Smarter Wi-Fi is a Strategic Imperative for the Education Market

Conventional Wi-Fi Just Doesn't Cut It

Wi-Fi was initially conceived and developed as a consumer technology of convenience within the home. Today, Wi-Fi is expected to be a reliable utility, supporting isochronous streams of IP video, delivering extensive and strong signal coverage, avoiding interference and allowing access to hundreds of simultaneous users on every access point. Like many organizations, schools must now deal with students, teachers and staff now armed with not one, but many Wi-Fi-enabled smart devices. These devices have weak Wi-Fi implementations and are constantly changing their orientation. Traditional Wi-Fi systems can't adapt to these or other environmental changes that effectively decimate wireless performance. IT administrators must look for a new generation of Wi-Fi technology able to cope with these new user demands.

Smarter Wi-Fi Infrastructure Delivers Simply Better Wireless

Recent advances in Wi-Fi technology now enable Wi-Fi systems to automatically adapt to constantly changing environmental conditions — allowing schools to deploy fewer access points (APs) that provide greater coverage and faster, more reliable performance. The innovation of adaptive antenna technology automatically focuses and directs Wi-Fi signals only where they are needed for any given user — constantly steering those signals over the fastest paths in real time. This mitigates packet loss to ensure more reliable connections while allowing more users to access the Wi-Fi network. Adaptive antenna technology also uniquely extends Wi-Fi signal range by 2 to 4X and is able to dynamically send and receive signals in different orientations as the client devices are moved around. This adaptive antenna technology, integrated into next-generation Wi-Fi APs, is augmented with sophisticated controller technology to give administrations the ability to easily on-board user devices and remotely manage mobile devices.

Causing a Ruckus in Wireless

Ruckus Wireless markets and manufactures ZoneFlex, a centrally managed, indoor/outdoor wireless LAN system purpose-built for the education market. Ruckus is widely considered the leader in delivering reliable wireless schools, school districts and universities around the world.

Patented Ruckus technology uniquely gives school IT administrations the ability to:

- Reduce CAPEX and OPEX associated with WLAN deployments
- Deliver more consistent performance at longer distances
- Automatically mitigate interference and adapt Wi-Fi signals to changing conditions
- Increase signal coverage with fewer APs than conventional enterprise alternatives
- Support larger numbers of concurrent Wi-Fi users per AP
- Deploy APs without the need to run Ethernet cabling to each AP (Smart Meshing)
- Easily on-board users and provide mobile device management (BYOD and MDM)
- Eliminate recurring broadband costs through the use of long range point to multipoint Wi-Fi

Ruckus® Simply Better Wireless.

For more information, please visit www.ruckuswireless.com.

Sponsors:

Acknowledgements:

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THE CENTER FOR DIGITAL EDUCATION is a national research and advisory institute specializing in K-12 and higher education technology trends, policy and funding. Along with its research services, CDE issues white papers and conducts the annual Digital School Districts and Digital Community Colleges surveys and award programs as well as hosting events across the K-12 and higher education arena. CDE also supports the Converge media platform comprised of the quarterly themed Converge Special Reports, Converge Online, and custom publishing services.

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The New Revolution in Networking

Meeting the Needs of Higher Education with Software-Defined Networks

Today's research and education networks connect faculty, researchers and students worldwide for projects that require extensive collaboration and transfers of enormous data volumes. Yet meeting the diverse and growing needs of these academic users is a challenge for university networks. With their fixed design and configuration, traditional networks simply can't support the unpredictable and dynamic flexibility required for emerging types of applications, new levels of collaboration and increased speeds of data flow.

To solve this challenge — which also exists for businesses and government organizations — the networking industry is focusing on a new concept: **software-defined networks**.

Understanding the Use Cases

Higher education institutions can use SDN to their advantage to support several areas, including:

- **Network bandwidth and services** that are dedicated for scientific research (called Science DMZs), as a way to better support the demanding communication needs of these projects
- **Scalability for the very large volumes of data** involved in research and instructional activity across all academic disciplines
- **Secure delivery** of Internet-based or private cloud applications and services to all campus users
- **Efficient use of server and storage resources** in a university's data centers and high-performance computing (HPC) environments
- **Research and development** of new networking designs and technologies by an institution's faculty, students, spinoff companies and business partners

Reaping the SDN Benefits

SDN expands a researcher's or academic user's ability to innovate and provides numerous benefits to higher education institutions. Because SDN supports open and interoperable systems, this leads to more efficient network designs, targeted bandwidth and service delivery, and the ability to customize the network — which means cost savings for institutions. Any-sized institution can offer the same network capabilities and performance levels as a large research university, improving collaboration. Additionally, SDN allows institutions to improve network flexibility, deliver more network-based services to users, and take advantage of open standards and software.

WHAT ARE SOFTWARE-DEFINED NETWORKS?

Software-defined networks (SDNs) allow applications to use open programming interfaces to control and allocate network resources for the distinct needs of the application's users, processes and data types. SDN essentially separates the data from the network components that transport it, which overcomes the barriers of traditional network protocols for supporting massive collaboration and data transfer activity as well as specialized user needs.

For additional information about software-defined networking and how it can benefit your institution, download a free copy of the Center for Digital Education's white paper *"The New Dynamism in Research and Education Networks"* at **www.centerdigitaled.com/paper/The-New-Dynamism-in-Research-and-Education-Networks.html**.

Share best practices and learn about more SDN use cases from your peers at the new Brocade Education Community site. ***Visit http://community.brocade.com/edu today!***

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